

REPAIRING, MAINTAINING, AND CALIBRATING METEOROLOGICAL INSTRUMENTS IN THE FIELD

- Purpose** This Air Quality Group procedure describes repair, maintenance, and calibration work performed in the field in support of the ESH-17 Meteorological Monitoring Project.
- Scope** This procedure applies to field repair, maintenance, and calibration work performed by ESH-17 Meteorological Monitoring Project personnel.
- Hazard Control Plan** The hazard evaluation associated with this work is documented in Attachment 1: Initial risk = **low**. Residual risk = **low**. Work permits required: none.
First authorization review date is one year from group leader signature below; subsequent authorizations are on file in group office.

Signatures

Prepared by: Bill Olsen, ESH-17	Date: <u>3/01/00</u>
Approved by: Jeff Baars, Meteorology Monitoring Project Leader	Date: <u>3/01/00</u>
Approved by: Terry Morgan, QA Officer	Date: <u>3/02/00</u>
Work authorized by: Doug Stavert, ESH-17 Group Leader	Date: <u>3/06/00</u>

04/13/00

CONTROLLED DOCUMENT

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General information about this procedure

In this procedure

This procedure addresses the following major topics:

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Attachments

This procedure has the following attachments:

Number	Attachment Title	No. of pages
1	Hazard Control Plan	3

History of revision

This table lists the revision history and effective dates of this procedure.

Revision	Date	Description of Changes
0	5/27/99	New document.
1	3/9/00	Changed requirements for climbing Pajarito Mountain tower.

General information, continued

Who requires training to this procedure?	<p>The following personnel require training before implementing this procedure:</p> <ul style="list-style-type: none">• the meteorological instrumentation technician assigned to calibrate, maintain, or repair meteorological instruments in the field
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Annual retraining is required and will be by self-study (“reading”) training.

Training method	<p>The training method for this procedure is on-the-job training by a previously trained individual and is documented in accordance with the procedure for training (ESH-17-024).</p>
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Prerequisites	<p>In addition to training to this procedure, the following training is also required prior to performing this procedure:</p> <ul style="list-style-type: none">• Ladder safety course #12985• ESH-17-401, “Meteorological Tower Climbing and Support”• ESH-17-402, “Calibration and Maintenance of Instruments for the Meteorological Monitoring Program”
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Discretion is a must in all aspects of this project. A good mechanical ability with knowledge of tools is important. Meteorological knowledge is important for worker safety -- an awareness of changes in the weather can be life-saving as in the event of developing cumulonimbus and the attendant lightning threat.

Periodically review the field safety information in the New Employee Handbook (see ESH-17-032).

General information, continued

References

The following documents are referenced in this procedure:

- ESH-17-024, “Personnel Training”
- ESH-17-035, “Work Safety Review and Authorization”
- ESH-17-401, “Meteorological Tower Climbing and Support”
- ESH-17-402, “Calibration and Maintenance of Instruments for the Meteorological Monitoring Program”
- Operator’s Manual For SWS-211-3Sx, Three Axis Sonic Anemometer/Thermometer
- Technical Manual For The AeroVironment Model 2000 Doppler Acoustic Sodar
- Tower Log Notebook (a bound laboratory notebook that briefly notes all work from instrument work through data editing). The Tower Log Notebook covers all meteorological sites and is issued for one year.
- Tower Log Activity Notebooks (notebooks containing all instrument calibration information for each meteorological site)

Note

Actions specified within this procedure, unless preceded with “should” or “may,” are to be considered mandatory guidance (i.e., “shall”).

Accessing meteorological sites

Overview Site access is different for each meteorological monitoring site. Below are specific requirements and instructions for accessing each site. The meteorological instrumentation technician has keys to access all locks described in this section. A four wheel drive government pickup truck is assigned to the Meteorological Monitoring Project to support project work. The truck has a bed shell to protect tools and a ladder rack. This truck is used to provide transportation for personnel, tools, ladders, instruments, and other equipment to and from meteorological monitoring sites.

TA-41, 49, and 54 TA-41, 49 & 54 have no access control or notification requirements. Keys to gate locks are needed to access these tower sites.

TA-53 Access requires a LANL badge and facility-specific training. Keys to a gate lock are needed to access the tower site.

Steps to access TA-6 To access TA-6 sites, perform the following steps:

Step	Action
1	Check with the receptionist in the lobby of TA-22, bldg. 90 to verify that it is safe to go to the tower site.
2	Sign the access log maintained in the lobby of TA-22, bldg. 90.
3	Upon arrival at the tower, call the FMU office at 667-0489 to tell them that you are working at 6-78.
4	When you leave the area, call the FMU office and notify them of your departure.
5	Return to TA-22, bldg. 90 to sign out in the access log.

Accessing meteorological sites, continued

Pajarito Mountain

Access to the Pajarito Mountain (PJMT) tower is controlled by the Los Alamos Ski Club. The PJMT tower is a cellular telephone transmitting tower owned by AirTouch. It is not necessary to contact the AirTouch site technician for doing any ground level work, even within the fenced area at the tower base. If it is necessary to climb the tower, then the AirTouch site technician must be notified prior to the ascent and the climber must wear EMR (electro-magnetic radiation) protective coveralls. The coveralls are an AirTouch requirement because the transmitters are still active.

Steps to access Pajarito Mountain To access the Pajarito Mountain tower site, perform the following steps:

Step	Action
1	Contact Mike Green at 690-1668 to obtain permission to go to the tower site. If Mike is not available, contact Bill Cox, the Mountain Manager, at 662-5952 or 690-1667.
2	Drive to the access gate located at the base of the ski area. The gate is located near the heavy equipment maintenance building and is open during normal working hours.
3	Fill out the log located near the gate before going up the mountain. The logbook is in a locked pedestal-mounted box. The meteorological instrument technician knows the combination.
4	When there is no snow on the mountain, drive to the tower site from the base of the ski area. During the ski season when the lifts are operating, contact Mike Green or Bill Cox to make arrangements to ride the chair lift.
5	If tower climbing is required, contact the AirTouch site technician (Mike Ross, 690-0004) before the ascent. This prior notification is an AirTouch requirement. Follow all the instructions outlined in ESH-17-401, "Meteorological Tower Climbing and Support". When the tower work is finished, contact the site technician and notify him that tower climbing activities have been completed.
6	After returning to the base of the mountain from the tower site, sign out in the log located near the gate.
7	Call the contacts from Steps 1 and 5 to inform them of your departure.

Accessing meteorological sites, continued

Overview of accessing rain gauge only sites

There are three rain-gauge-only sites located at TA-74, NCOM, and TA-16. Instrument access is different for each site. Below are specific requirements and instructions for accessing rain gauge sites.

TA-74

The TA-74 site is located near the State Highway Department facility at the White Rock “Y” intersection where State Road 502 and State Road 4 join. The rain gauge site is inside a fenced area locked with a padlock near the Highway Department facility. During the summer, the State Highway Department does not staff their facility at this site and the gate used to drive into the facility is normally locked. When the gate is locked, access the fenced in rain gauge site on foot.

North community

The north community (NCOM) rain gauge is located on the roof of the volunteer fire department building at 4017 Arkansas Avenue. It is necessary to climb a caged ladder to the roof. The datalogger for this rain gauge is located in the basement of the building. The basement is locked.

Steps to access NCOM rain gauge

To access the NCOM rain gauge, perform the following steps:

Step	Action
1	Drive to 4017 Arkansas Avenue.
2	To access the gauge, climb the caged ladder to the roof. NOTE: The gauge is easily identified and has a sign indicating that it is an ESH-17 meteorological monitoring site.
3	To access the datalogger, unlock the basement door located at the rear of the building. NOTE: The datalogger is housed in a locked fiberglass box located just inside the door and is identified with a sign.

Accessing meteorological sites, continued

TA-16 The TA-16 rain gauge is on the roof of building 209. The datalogger is located inside the building.

Steps to access TA-16 rain gauge To access the TA-16 rain gauge, perform the following steps:

Step	Action
1	Load the extension ladder on the truck in place of the 8-foot step ladder.
2	Use the extension ladder from the truck to access rain gauge on the roof of building 16-209. When you reach the roof, tie the ladder to the building. NOTE: Building 16-209 is only 20 ft square. The gauge is readily apparent and is identified with an ESH-17 meteorological monitoring site sign.

Steps to access TA-16 datalogger To access the TA-16 datalogger, perform the following steps:

Step	Action
1	Go to the S-site Access Control Office in building 16-202 and request a key to building 16-209. Explain that you are not going into any controlled areas and need an exchange badge with a key to bldg. 16-209. NOTE: The Access Control Office will keep your LANL badge until you return the exchange badge.
2	Drive to building 16-209. Remove the 3-foot step ladder from the truck and use it to access the datalogger, which is inside the building in a fiberglass box on a high shelf.
3	After completing the work and removing all tools and equipment used, lock building 16-209 and return the key and exchange badge to the Access Control Office. Retrieve your LANL badge.

TA-6, TA-41, TA-49, TA-53, TA-54, & PJMT tower instrument field work

Overview Rain gauges are calibrated at the site and repaired and cleaned as part of the calibration cycle. The sonic anemometers, dataloggers, and sodar are also calibrated in situ. All other tower instrument calibrations are performed in the Meteorology Lab at TA-59 or the instruments are returned to the manufacturers for re-calibration. The re-calibrated instruments are then exchanged with the instruments in use at the sites.

Required equipment and supplies The following equipment and supplies are needed to perform work:

- three foot ladder
- eight foot ladder
- hand tools such as screw drivers, wrenches, hammers
- carpenter's level
- az-scope
- tower elevator gap-fillers
- test cables
- Loctite 242 Removable Threadlocker
- pipette (for liquid measure)
- voltmeter
- one liter bottle of water

Aligning propvane locator ring The propvane azimuth measurement systems must be aligned to a true north reference. The alignment landmarks for the towers are shown in tables below.

Steps to align propvane locator ring To align a propvane locator ring, perform the following steps:

Step	Action
1	Install the az-scope on the propvane locator ring. Note: The propvane locator ring has a pin that engages the az-scope and the propvane.

TA-6, TA-41, TA-49, TA-53, TA-54, & PJMT tower instrument field work, continued

Step	Action																												
2	<p>Using the az-scope, check the vane angle alignment against the references given below. If adjustment is required and performed, record the adjustment in the Tower Log Notebook.</p> <table> <tr> <th>Tower</th><th>Landmark</th></tr> <tr> <td>TA-6</td><td>guyed commercial radio tower on Pajarito Mtn</td></tr> <tr> <td>TA-41</td><td>guyed commercial radio tower on Pajarito Mtn</td></tr> <tr> <td>TA-53</td><td>guyed commercial radio tower on Pajarito Mtn</td></tr> <tr> <td>TA-49</td><td>TA-33 water tower</td></tr> <tr> <td>TA-54</td><td>unique mountain feature to the SE of the tower</td></tr> <tr> <td>PJMT</td><td>TA-6 meteorological tower</td></tr> </table> <table> <tr> <th>Tower</th><th>Reference Angle</th></tr> <tr> <td>TA-6</td><td>293.5 degrees (66.5 degrees west of true north)</td></tr> <tr> <td>TA-41</td><td>277.25 degrees (82.75 degrees west of true north)</td></tr> <tr> <td>TA-53</td><td>278.1 degrees (81.9 degrees west of true north)</td></tr> <tr> <td>TA-49</td><td>130.75 degrees (130.75 degrees east of true north)</td></tr> <tr> <td>TA-54</td><td>155.75 degrees (155.75 degrees east of true north)</td></tr> <tr> <td>PJMT</td><td>113.0 degrees (113. Degrees east of true north)</td></tr> </table> <p>NOTE: The propvane locator ring measurement is normally only a verification that the propvane locator ring is properly set. The locator ring is mechanically locked to the boom and not subject to accidental change or drift.</p>	Tower	Landmark	TA-6	guyed commercial radio tower on Pajarito Mtn	TA-41	guyed commercial radio tower on Pajarito Mtn	TA-53	guyed commercial radio tower on Pajarito Mtn	TA-49	TA-33 water tower	TA-54	unique mountain feature to the SE of the tower	PJMT	TA-6 meteorological tower	Tower	Reference Angle	TA-6	293.5 degrees (66.5 degrees west of true north)	TA-41	277.25 degrees (82.75 degrees west of true north)	TA-53	278.1 degrees (81.9 degrees west of true north)	TA-49	130.75 degrees (130.75 degrees east of true north)	TA-54	155.75 degrees (155.75 degrees east of true north)	PJMT	113.0 degrees (113. Degrees east of true north)
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3	<p>After checking or setting the locator ring alignment, remove the az-scope and install the propvane.</p> <p>NOTE: The vane angle calibrator has a corresponding locator pin and the propvanes and az-scope have matching receptacles. The vane angle calibrator is the instrument used to calibrate the propvanes' azimuth measurement systems. The az-scope is also calibrated with the vane angle calibrator. In this way, the azimuth calibration is easily transferred from the calibration standard to the final installation.</p>																												
4	Clamp the propvane in position.																												
5	Verify the propvane is properly oriented by checking the azimuth angle indicated on the datalogger.																												

Removing and installing TA-6, TA-49, TA-53, & TA-54 tower instruments

Overview

The following procedure allows the operator to check the as-is condition of booms and the alignment of the azimuth vanes for each carriage. The elevator system has a limit switch at the nine foot level to ensure that the carriage isn't lowered too far and each carriage has a limit in its umbilical connector to ensure proper engagement when the carriages are raised back to their stations. It is important that the carriage positions on the lifting cable be marked with paint and measured so that the carriage is reinstalled at the correct position on the lifting cable.

Steps to remove instruments

To remove instruments from the tower, perform the following steps:

Step	Action
1	Using the tower's winch, lower each tower carriage to within nine feet of the ground for preliminary operational checks of the mounted instruments on that carriage's boom. NOTE: The stopping position is controlled by a limit switch.
2	Use a ladder to gain access to the carriage and instruments mounted on the carriage boom. Ensure the ladder is positioned on firm level ground and that the legs are in equal contact with the ground.
3	Check the boom with a carpenter's level to verify that it is level.
4	Remove the propvane, install the az-scope on the propvane mount, and note the azimuth angle measured when the az-scope is aligned on the landmark. If needed, adjust the propvane's azimuth locator ring. NOTE: These reference angles are contained in the table in Step 2 of the previous section of this procedure.
5	Using white paint, mark a band (about 3 in. wide) on the lifting cable in the center area of the carriage.
6	After the paint has dried, use a felt tip pen to mark a line on the lifting cable six inches below the top aluminum structural member of the carriage. NOTE: This mark will be used to reposition the carriage on the lifting cable when the carriage is reinstalled.
7	Install the two gap-fillers at the bottom of the elevator system's two rails. NOTE: These gap-fillers will rest on the elevator winch housing.

Removing and installing TA-6, TA-49, TA-53, & TA-54 tower instruments, continued

Step	Action
8	Using the tower's winch, carefully lower the carriage onto these gap-fillers and use cable ties to lock the carriage rollers to the gap-fillers.
9	Remove the two cable clamps attaching the carriage to the lifting cable.
10	Transfer this carriage to one of the holding stands next to the tower.
11	Remove the vertical wind anemometer.
12	Open the temperature instrument radiation shield and remove the thermistor probe.
13	Repeat steps 1-12 for each carriage on the tower except the last carriage. Leave the last carriage at the nine foot level still attached to the lifting cable.
14	Return the removed instruments to the meteorological laboratory for post-calibration. NOTE: Calibration is performed in accordance with ESH-17-402.

Steps to install instruments To install the instruments, perform the following steps:

Step	Action
1	Ensure instruments are installed in the correct positions by verifying serial numbers as assigned on the instrument calibration sheets.
2	If it is time to replace the temperature instrument's aspirator fan, disassemble the radiation shield to gain access to the fan and replace it.
3	Install a re-calibrated temperature thermistor probe in the solar radiation shield.
4	Install a refurbished vertical wind anemometer.
Install a refurbished propvane	
5	Set the propvane on the mounting post and engage the locator pin on the azimuth locator ring in the receptacle on the propvane.
6	Apply Loctite to the threads of the two set screws that hold the propvane on the mounting post.
7	As viewed from the top of the propvane, rotate the propvane counterclockwise against the locator pin to remove slack in the mounting system.
8	Tighten the set screw that supports the slack removal process first. Then tighten the other set screw.
9	Reconnect any connections that were disconnected and reassemble anything that was disassembled.
10	Repeat steps 1-9 for each tower instrument level.

Removing and installing TA-6, TA-49, TA-53, & TA-54 tower instruments, continued

Step	Action
11	Record the time and date of installation and sign the calibration sheets. NOTE: These calibration sheets were created when the instruments were calibrated in accordance with procedure ESH-17-402.
12	File the calibration sheets for the instruments just installed in the calibration log section of the appropriate Tower Activity Log Notebook.

Steps to re-install carriages

To re-install carriages on the tower, perform the following steps:

Step	Action
1	Use the tower's winch to raise the top level boom. Stop the winch when the next painted section on the lifting cable emerges from the winch housing.
2	Remove the next carriage from the holding stand near the tower.
3	Carry this carriage to the tower base and place the two gap fillers, which are attached to the carriage, into the space (gap) between the bottom of the rails and the top of the winch housing.
4	Hook the top edge of the gap fillers to the bottom of the rails and set the bottom of the gap fillers on the winch housing.
5	Engage the lock bolts of the gap fillers with the bottom of the rails.
6	Use the tower's winch and a measuring tape to position the lifting cable so that the alignment mark on the cable is again six inches below the top aluminum structural member.
7	Attach a cable clamp to clamp the lifting cable to the top aluminum structural member of the carriage.
8	Remove the cable ties which clamp the gap fillers to the carriage.
9	Use the tower's winch to raise the carriage above the gap fillers (i.e., the carriage is totally on the tower rails).
10	Attach a cable clamp to clamp the lifting cable to the bottom aluminum structural member of the carriage.
11	Connect a test cable from the carriage's umbilical connector to the corresponding carriage station test connector mounted on the tower J-box. NOTE: This will complete the connection to the station datalogger.

Removing and installing TA-6, TA-49, TA-53, & TA-54 tower instruments, continued

Step	Action
12	Point the propvane at the known azimuth alignment landmark, then clamp the propvane and compare the reading displayed on the datalogger to the known landmark azimuth angle. Note this value in the “comments” section of the propvane CMF1 form.
13	Remove the clamp from the propvane.
14	Disconnect the test cable from the carriage’s umbilical connector.
15	Use the tower’s winch to raise this carriage. Stop the winch when the next painted section on the lifting cable emerges from the winch housing.
16	Repeat steps 2 through 15 until all carriages are installed.
17	Raise the carriages until they connect to their tower mounted umbilical connectors.
18	Check the indicator lights to make sure that the carriages have connected to their respective connectors.
19	If one or more carriages have not engaged their respective umbilical connectors, use the winch control’s limit override switch to “bump” the carriages up until all the indicator lights are lit.
20	If the bumping is not successful, lower the carriages again and adjust the position of the affected carriage(s) on the lifting cable and raise the carriages back into position.
21	Make an entry in the Tower Log Notebook citing: <ul style="list-style-type: none">• the work completed,• a description of any adjustments made,• data editing requirements,• the period for which the edits are required, and• any other pertinent information. Sign and date the entry.

Removing and installing TA-41 tower instruments

Overview The TA-41 meteorology tower is equipped with a tilt-over mechanism. The tower is tilted over to gain access to the instruments.

Steps to remove instruments To remove the instruments at TA-41, perform the following steps:

Step	Action
1	Connect the tower electrical limit switches and connect the AC power plug.
2	Turn on the motor control with the key switch and use the motor control to lower the telescoping tower to its least extension.
3	Remove the tower base bolts to allow the tower to be tilted over.
4	Disconnect the tower limit switches and the AC power plug.
5	Use the hand winch to tilt the tower for easy access to the instruments.
6	Use an eight foot ladder to reach the vertical wind anemometers. NOTE: The propvanes and temperature transducers may be accessed at ground level.
7	Remove the vertical wind anemometers and the propvanes.
8	Open the temperature instrument radiation shield and remove the thermistor probe.
9	Remove the pyranometer.
10	Calibrate the datalogger in accordance with procedure ESH-17-402. Note: This is a convenient time to calibrate the datalogger because none of the instruments are connected.

Steps to install instruments To install the instruments at TA-41, perform the following steps:

Step	Action
1	Ensure instruments are installed in the correct positions by verifying serial numbers as assigned on the instrument calibration sheets.
2	If it is time to replace the temperature instrument's aspirator fan, disassemble the radiation shield to gain access to the fan. Replace it with another fan.

Removing and installing TA-41 tower instruments, cont.

Step	Action
Install refurbished propvanes	
3	Set the propvane on the mounting post and engage the locator pin on the azimuth locator ring in the receptacle on the propvane.
4	Apply Loctite to the threads of the two set screws that hold the propvane on the mounting post.
5	As viewed from the top of the propvane, rotate the propvane counterclockwise against the locator pin to remove slack in the mounting system.
6	Tighten the set screw that supports this slack removal process first, then tighten the other set screw.
7	Repeat steps 1-7 for each tower instrument level.
8	Record, on the instrument calibration sheets, the date and time the instruments were installed. Sign the sheets. NOTE: The calibration sheets were created when the instruments were calibrated in accordance with procedure ESH-17-402.
9	File the calibration sheets for the instruments just installed in the Tower Activity Log Notebook.

Steps to re-erect the tower

To re-erect the TA-41 tower, perform the following steps:

Step	Action
1	Use the hand winch to rotate the tower back to the vertical position.
2	Replace and tighten the tower base bolts.
3	Connect the tower electrical limit switches and connect the AC power plug.
4	Use the motor control to telescope the tower to full vertical extension.
5	Turn off the motor control with the key switch.
6	Disconnect the AC power plug.
7	Make an entry in the Tower Log Notebook citing: <ul style="list-style-type: none"> the work completed, a description of any adjustments made, data editing requirements, the period for which the edits are required, and any other pertinent information. Sign and date the entry.

Removing and installing PJMT tower instruments

Overview

The tower instruments at Pajarito Mountain (PJMT) are accessed by climbing the tower. All equipment and a newly calibrated propvane are carried to the top of the tower and the propvane is exchanged in one trip.

Steps to remove and install instruments

To remove and install PJMT tower instruments, perform the following steps:

Step	Action
1	Upon reaching the PJMT tower measurement station, ready all the necessary equipment to be carried up the tower.
2	Refer to procedure ESH-17-401, "Meteorological Tower Climbing and Support" for information defining requirements for tower climbing.
3	Climb the tower and remove the propvane.
4	Set the refurbished propvane on the monitoring post and engage the locator pin on the azimuth locator ring in the receptacle on the propvane.
5	As viewed from the top of the propvane, rotate the propvane anti-clockwise against the locator pin to remove slack in the mounting system.
6	Tighten the hose clamp on the propvane base to secure the propvane to the mounting post.
7	Connect the signal wires to the terminals in the propvane junction box.
8	Replace the temperature transducer with a newly calibrated unit. Note: The temperature solar radiation shield is a naturally aspirated device that requires no maintenance.
9	Record, on the instrument calibration sheets, the date and time the instruments were installed. Sign the sheets. NOTE: The calibration sheets were created when the instruments were calibrated in accordance with procedure ESH-17-402.
10	File the calibration sheets for the instruments just installed in the PJMT Tower Activity Log Notebook.
11	Make an entry in the Tower Log Notebook citing: <ul style="list-style-type: none"> the work completed, a description of any adjustments made, data editing requirements, the period for which the edits are required, and any other pertinent information. Sign and date the entry.

Removing and installing the sodar's uvw anemometer mounted at the 10m level of the TA-6 tower

Overview

The sodar's uvw anemometer is mounted on a boom at the 10m level on the TA-6 meteorological tower. This boom is mounted on the tower and can only be accessed by climbing the tower. The boom is attached to the tower with a hinged adapter and is held in a horizontal position with an angle brace from the boom to the tower.

Steps for removing and installing anemometer

To remove and install the uvw anemometer, perform the following steps:

Step	Action
1	Refer to procedure ESH-17-401, "Meteorological Tower Climbing and Support" for information defining requirements for tower climbing.
2	Climb the tower to the 10m level to access the anemometer.
3	Remove the bolt at the bottom of the boom angle brace.
4	Use the angle brace as a handle to slowly swing the hinged boom down to access the anemometer.
5	Climb down to the anemometer.
6	Replace the individual arms of the anemometer with refurbished units, including propellers.
7	Ensure the instrument arms are installed in the correct positions by verifying the serial numbers as assigned on the instrument calibration sheets.
8	Climb back to the position near the bottom end of the angle brace attachment point.
9	Use the angle brace as a handle to slowly raise the hinged boom back to its operating position.
10	Reinstall the bolt at the bottom of the boom angle brace.
11	Record, on the instrument calibration sheet, the date and time the instrument was installed. Sign the sheet. NOTE: The calibration sheet was created when the instrument was calibrated in accordance with procedure ESH-17-402.
12	File the calibration sheet for the instrument just installed in the Sodar Tower Activity Log Notebook.

Removing and installing the sodar's uvw anemometer mounted at the 10m level of the TA-6 tower, cont.

Step	Action
13	<p>Make an entry in the Tower Log Notebook citing:</p> <ul style="list-style-type: none">• the work completed,• a description of any adjustments made,• data editing requirements,• the period for which the edits are required, and• any other pertinent information. <p>Sign and date the entry.</p>

Removing and installing tower site ground level instruments

Overview The ground level instruments include temperature, relative humidity, barometric pressure and solar radiation. Not all sites have all the same ground level instrumentation.

Steps for removing and installing instruments To remove and install tower site ground level instruments, perform the following steps:

Step	Action
1	Replace the level 0 (1.2 m) temperature probe and if necessary the aspirator fan.
2	Replace the level 0 relative humidity probe.
Replace the up-facing solar pyranometer(s) or pyrgeometer(s)	
3	Remove the solar heat shield, disconnect the connector, remove the screws holding the unit in the aspirator housing, and remove the unit.
4	Set the new unit in place in the aspirator housing.
5	Reconnect the connector and replace the mounting screws.
6	Level the unit using its attached bull's-eye level. Use the six screws around the perimeter of the aspirator housing to level the unit.
7	After leveling the unit, re-attach the solar heat shield.
Replace the down-facing solar pyranometer and pyrgeometer	
8	Disconnect the connector, then carefully support the unit and remove the mounting screws.
9	Hold the new unit in place and replace the mounting screws leaving them slightly loose so that the unit can be leveled.
10	Set a 12" scale on the upper surface of the unit. NOTE: This would be the bottom-side of the unit since it is downfacing.
11	Set a bull's-eye level on the portion of the scale that extends beyond the unit.
12	Adjust the mounting screws to level the unit with the bull's-eye level.
13	After leveling the unit, adjust its thumbscrews up to the mounting plate to secure the setting.
14	Reconnect the connectors.
Other instruments	
15	Calibrate the snow depth gauge (TA6 & PJMT) and lightning detector (TA6) per ESH-17-402.
16	Exchange the barometric pressure instrument with a newly calibrated unit.

Removing and installing tower site ground level instruments, continued

Step	Action
17	Record, on the instrument calibration sheets, the date and time the instruments were installed. Sign the sheets. Note: The calibration sheets were created when the instruments were calibrated in accordance with procedure ESH-17-402.
18	File the calibration sheets for the instruments just installed in the Tower Activity Log Notebook.
19	Make an entry in the Tower Log Notebook citing: <ul style="list-style-type: none">• the work completed,• a description of any adjustments made,• data editing requirements,• the period for which the edits are required, and• any other pertinent information. Sign and date the entry.

Rain gauge field work

Overview

The rain gauges at the tower sites and TA-74 are all in locations about 1.5 meters above the ground. The rain gauges at TA-16 and NCOM are located on roof tops.

To calibrate rain gauges

To calibrate the rain gauges, perform the following steps:

Step	Action
1	Follow the instructions in procedure ESH-17-402 to clean, repair, and calibrate rain gauges.
2	Record, on the instrument calibration sheets, the date and time the instruments were calibrated. Sign the sheets. NOTE: The calibration sheets are created when the instruments are calibrated in accordance with procedure ESH-17-402.
3	File the calibration sheets for the instruments in the appropriate Tower Activity Notebook.
4	Make an entry in the Tower Log Notebook citing: <ul style="list-style-type: none">• the work completed,• a description of any adjustments made,• data editing requirements,• the period for which the edits are required, and• any other pertinent information. Sign and date the entry.

Datalogger field work

Overview The dataloggers are contained in buildings and shelters for each meteorological measurement site and are easily accessed.

To calibrate rain gauges To calibrate the dataloggers, perform the following steps:

Step	Action
1	Follow the instructions in procedure ESH-17-402 to clean, repair, and calibrate dataloggers.
2	Record, on the dataloggers calibration sheets, the date and time the dataloggers were calibrated. NOTE: The calibration sheets are created when the instruments are calibrated in accordance with procedure ESH-17-402.
3	File the calibration sheets for the dataloggers just calibrated in the appropriate Tower Activity Log Notebook.
4	Make an entry in the Tower Log Notebook citing: <ul style="list-style-type: none">• the work completed,• a description of any adjustments made,• data editing requirements,• the period for which the edits are required, and• any other pertinent information. Sign and date the entry.

Sonic anemometer field work

Overview Sonic anemometer calibration is well documented in the equipment manual. Follow that procedure. The sonic transducer assembly is mounted on the level 1 tower boom and this calibration is done as a last step before the level 1 is returned to its station.

Steps to calibrate the anemometer

To calibrate the anemometer, perform the following steps:

Step	Action
1	Using the tower's winch, position the level 1 boom at the nine foot above-the-ground position to allow access to the sonic transducer assembly.
2	Perform the calibration procedure described in the sonic anemometer equipment manual, in accordance with procedure ESH-17-402.
3	Using the tower's winch, run the carriages up to their normal operating positions and shut off the winch power.
4	Wait until a good 15 minute average data block has been collected by the tower and flux dataloggers. From each datalogger, note the corresponding values of wind speed and direction, vertical speed, and temperature, as recorded by the sonic (flux datalogger) and level one tower instruments (tower datalogger).
5	Record these measurements on the calibration sheet for the sonic anemometer. NOTE: The calibration sheet is created when the instrument is calibrated in accordance with procedure ESH-17-402.
6	Record, on the instrument calibration sheet, the date and time the work was performed. Sign the sheets.
7	File the calibration sheets for the instruments just installed in the TA-6 Tower Activity Log Notebook.
8	Make an entry in the Tower Log Notebook citing: <ul style="list-style-type: none"> the work completed, a description of any adjustments made, data editing requirements, the period for which the edits are required, and any other pertinent information. Sign and date the entry.

Fast response hygrometer field work

Overview The fast response hygrometer is mounted on the level 1 tower boom. This instrument is calibrated by the manufacturer. A newly-calibrated unit is installed when the level 1 boom is at the nine foot position.

Steps to install calibrated hygrometer To install a newly-calibrated hygrometer, perform the following steps:

Step	Action
1	Using the tower's winch, position the level 1 boom at the nine foot above-the-ground position, which allows access to the hygrometer.
2	Remove the old hygrometer from the boom and install the newly-calibrated unit, in accordance with procedure ESH-17-402.
3	Using the tower's winch, run the carriages up to their normal operating positions and shut off the winch power.
4	File the calibration sheet for the instrument just installed in the Tower Activity Log Notebook. Record the time and date of installation and sign the sheet.
5	Make an entry in the Tower Log Notebook citing: <ul style="list-style-type: none">• the work completed,• a description of any adjustments made,• data editing requirements,• the period for which the edits are required, and• any other pertinent information. Sign and date the entry.

Fuel moisture transducer field work

Overview Fuel moisture measurement is of primary importance through the summer fire season.

Steps to maintain fuel moisture transducer To maintain the fuel moisture transducer, perform the following steps:

Step	Action
1	During March or April, note the last 15 minute average reading of the old transducer (existing in the field) and record that value in the comments section of the calibration sheet for the refurbished transducer.
2	Remove the old transducer and replace it with the refurbished unit.
3	Note a 15 minute average reading from the installed refurbished transducer 24 hours after installation and record this value in the comments section of the calibration sheet. If the reading agrees within $\pm 5\%$ moisture of the reading from Step 1 (assuming weather conditions have not changed drastically), the new transducer is functioning correctly.
4	File the calibration sheet for the instrument just installed in the Tower Activity Log Notebook.
5	Make an entry in the Tower Log Notebook citing: <ul style="list-style-type: none">• the work completed,• a description of any adjustments made,• data editing requirements,• the period for which the edits are required, and• any other pertinent information. Sign and date the entry.

Subsurface measurement instrument field work

Overview

Subsurface measurements are made at the TA-6 and TA-54 tower sites. The instruments are buried at various depths up to 18 cm below the ground surface. Optimal installation is in undisturbed soil. To that end, care is used during instrument installation to minimize disturbing the soil and damaging plants and their roots. Any periodic work on these instruments, such as annual calibrations, would be detrimental to this objective.

The instruments are disturbed only if there is evidence of damage or other malfunction. This can be determined by intra-comparisons of the measurements. This is possible because of the numbers of instruments measuring the same variable under slightly different conditions. For example, temperature is measured at 2 and 6 cm depths in two different locations about 1.5 meters apart, there are two ground heat flux plates about 1.5 m apart, and there are two soil moisture probes.

Steps to maintain instruments

To maintain subsurface measurement instruments, perform the following steps:

Step	Action
1	Begin by removing soil around the instrument cables at a distance away from the instruments. In this way, the instruments can be located with the least disruption of the soil and risk of instrument damage if blind probing of the soil is done.
2	Remove the suspect instrument and replace it with a unit calibrated in accordance with procedure ESH-17-402.
3	Disconnect the old instrument (just removed from the ground) at the "J" box and connect the new unit.
4	Replace the removed soil.
5	Record, on the instrument calibration sheet(s), the date and time the instruments were installed. Sign the sheet(s). NOTE: The calibration sheets were created when the instruments were calibrated in accordance with procedure ESH-17-402.
6	File the calibration sheet(s) for the instrument(s) just installed in the Tower Activity Log Notebook.
7	Make an entry in the Tower Log Notebook citing: <ul style="list-style-type: none"> the work completed, a description of any adjustments made, data editing requirements, the period for which the edits are required, and any other pertinent information. Sign and date the entry.

Site work associated with independent audit

Overview

To ensure the veracity of the meteorological measurements, we periodically employ the services of an outside contractor to conduct an independent audit. This contractor does calibration checks on all the instruments in the field following the guidance provided in ESH-17-402. For some of the instruments, the calibration check is with co-located NIST traceable instrumentation. Large blocks of recently collected data are also examined for inter- and intra-tower comparisons.

The contractor is on-site for about seven days to complete the field work and then an audit report is created to document all the findings.

Steps to perform an independent audit

To set up and perform an independent meteorology instrument audit, perform the following steps:

Step	Action
1	Create ES&H screening documentation for each tower site, since each tower site is in a separate Facility Management Unit (FMU).
2	Have the ES&H documentation signed by the responsible person in each FMU.
3	Create a purchase request for the independent audit.
4	Submit the ES&H screening documents with the purchase request.
5	Accompany the independent auditor(s) for all field work.
6	Provide security control access to TA-6 and escort the auditor(s) at all times.
7	Conduct the audit following the steps set out in this document, ESH-17-401, ESH-17-402, and the scope of the work contained in the purchase request.
8	Make an entry in the Tower Log Notebook citing: <ul style="list-style-type: none">the work completed,a description of any adjustments made,data editing requirements,the period for which the edits are required, andany other pertinent information. Sign and date the entry.

Site work associated with tower safety inspections

Overview

The tower safety inspection requires the services of a tower erection company who will send workers to Los Alamos for the inspection work. The workers will conduct a climbing inspection of each tower checking for corrosion, loose hardware, warning lights and operation, guying and guy tension, tower plumb, safety equipment integrity, and winch system operation.

Steps to perform safety inspection

To set up and perform a tower safety inspection, perform the following steps:

Step	Action
1	Create ES&H screening documentation for each tower site, since each tower site is in a separate Facility Management Unit (FMU).
2	Have the ES&H documentation signed by the responsible person in each FMU.
3	Create a purchase request for the tower safety inspection.
4	Submit the ES&H screening documents with the purchase request.
5	Accompany the inspector(s) for all field work.
6	Provide security control access to TA-6 and escort the inspector(s) at all times.
7	Make an entry in the Tower Log Notebook citing: <ul style="list-style-type: none"> the work completed, a description of any adjustments made, data editing requirements, the period for which the edits are required, and any other pertinent information. Sign and date the entry.
8	If problems are identified during the inspection, notify the Meteorology Monitoring Project Team Leader and take appropriate steps to have the problems corrected.
9	File the resulting inspection report in the files maintained at TA-59, building 0001, room 176.

Repairing, maintaining, or calibrating the sodar

Overview The sodar consists of three large antennas located at a distance of about 120 feet from the control electronics package, which is installed in building 91 at TA-6.

**Steps to
repair,
maintain, or
calibrate the
sodar**

To repair, maintain, or calibrate the sodar, perform the following steps:

Step	Action
1	Follow the instructions in procedure ESH-17-402 and the “Technical Manual For The AeroVironment Model 2000 Doppler Acoustic Sodar,” in accordance with procedure ESH-17-402. NOTE: Repair work is difficult to define since there are many avenues for system failure.
2	Make an entry in the Tower Log Notebook citing: <ul style="list-style-type: none">• the work completed,• a description of any adjustments made,• data editing requirements,• the period for which the edits are required, and• any other pertinent information. Sign and date the entry.

Additional meteorological work

Overview

Additional meteorological work includes installing new monitoring systems at existing or new monitoring sites and performing work requested by other ESH-17 projects or Laboratory organizations. This work is divided into two categories:

1. Work that is essentially identical to work described in a procedure, but is performed at a different monitoring site. The hazard analysis and mitigation is covered by existing Hazard Control Plans (HCPs). An existing HCP constitutes authorization to perform the work.
2. Work that varies significantly from work described in a procedure or is to be performed at a potentially hazardous location. Hazards may not be adequately covered by existing HCPs. This work will be considered non-routine work and a new HCP must be developed and approved in accordance with procedure ESH-17-035 before the work may be performed.

Determining if additional hazard analysis is needed

The individual proposing or planning additional work must consult with the Meteorological Monitoring Project Leader to determine if the hazards of the work are adequately covered by an existing HCP or if the additional work is non-routine work that requires a new HCP, pursuant to procedure ESH-17-035.

Records resulting from this procedure

Records

The following calibration and maintenance records generated as a result of performing these procedures are filed in the appropriate Tower Activity Log Notebook within one week of generation:

- Forms generated by the performance of calibration or maintenance work described in ESH-17-402
- Independent Instrument Calibration Audit reports
- Tower Safety Inspection reports
- Any notes or reports resulting from the performance of work described in the *Additional Meteorological Work* chapter of this procedure

The Tower Activity Log Notebooks and the Tower Log Notebook (a bound laboratory notebook) are maintained as records at TA-59, building 0001, room 176.

HAZARD CONTROL PLAN

1. The work to be performed is described in this procedure.

“Repairing, Maintaining, and Calibrating Meteorological Instruments in the Field”

2. Describe potential hazards associated with the work (use continuation page if needed).

1. Lightning.
2. Temperature.
3. Sun Exposure.
4. Snakes, spiders, wasps, etc.
5. Slips, trips and falls associated with uneven wet and/or snowy surfaces.
6. Use of ladders.
7. Use of hand tools (screwdrivers, wrenches, knives, pliers & wire cutters, etc.).
8. Use of hand power tools (drill motors, saber saw, Sawzall, soldering irons, etc.).
9. Heavy lifting.
10. Work at night.

3. For each hazard, list the likelihood and severity, and the resulting initial risk level (before any work controls are applied, as determined according to LIR300-00-01.0, section 7.2)

1. Remote / catastrophic = low
2. Occasional / moderate = low
3. Frequent / negligible = low
4. Improbable / critical = low
5. Occasional / moderate = low
6. Occasional / moderate = low
7. Occasional / negligible = minimal
8. Remote / moderate = minimal
9. Improbable / critical = low
10. Improbable. / moderate = minimal

Overall *initial* risk: ☐ Minimal ☒ Low ☐ Medium ☐ High

4. Applicable Laboratory, facility, or activity operational requirements directly related to the work:

☒ None ☐ List: Work Permits required? ☒ No ☐ List:

See continuation page 3.

HAZARD CONTROL PLAN, continued

5. Describe how the hazards listed above will be mitigated (e.g., safety equipment, administrative controls, etc.):

1. The lightning threat must be continuously monitored by the worker. Developing cumulonimbus clouds in the area are a definite indicator that it is time to monitor the lightning threat more closely. The Sweeney static meter is used to monitor this threat -- if the potential gradient exceeds 2,000 volts per meter, it is time to clear the area.

2. Cold temperatures pose a greater threat to the worker. The worker must be aware of the possibility of hypothermia which is exacerbated by wind and wet weather. The worker must dress appropriately for the weather conditions and possible conditions. Since a vehicle is typically at hand, then it is easy for the worker to seek shelter and an active heat source.

3. This topic is covered in the Employee Notebook required reading for all employees. Sun exposure can be minimized with proper clothing, such as long sleeves and a brimmed hat. It is also important to use a high number sun screen. The hazard of sun exposure is not just confined to summer.

See continuation page 3.

6. Knowledge, skills, abilities, and training necessary to safely perform this work (check one or both):



Group-level orientation (per ESH-17-032) and training to this procedure.



Other → See training prerequisites on procedure page 3. Any additional describe here:

7. Any wastes and/or residual materials? (check one) ☒ None ☐ List:

8. Considering the administrative and engineering controls to be used, the *residual* risk level (as determined according to LIR300-00-01.0, section 7.3.3) is (check one):



Minimal



Low



Medium (requires approval by Division Director)

9. Emergency actions to take in event of control failures or abnormal operation (check one):



None



List:

1. Contact the ESH-17 group office.

2. Arrange for appropriate transportation to the hospital or nearest Occupational Medicine Group medical station.

Signature of preparer of this HCP: This HCP was prepared by a knowledgeable individual and reviewed in accordance with requirements in LIR 300-00-01 and LIR 300-00-02.

Preparer(s) signature(s)

Name(s) (print)

/Position

Date

Signature by group leader on procedure title page signifies authorization to perform work for personnel properly trained to this procedure. This authorization will be renewed annually and documented in ESH-17 records. Controlled copies are considered authorized. Work will be performed to controlled copies only. This plan and procedure will be revised according to ESH-17-022 and distributed according to ESH-17-030.

HAZARD CONTROL PLAN, continued

ITEM 4: APPLICABLE REQUIREMENTS

TA-53: TA-53 Facility-specific Training

TA-6 ENTRANCE CONTROL: Go to bldg:TA-22-90 to sign the access control log and obtain verbal confirmation that there will not be any explosive testing that will create a hazard. Call the FMU office at 667-0489 to tell them that you will be working at TA-78.

TA6 EXIT CONTROL: Go to bldg. 90 to sign out and call the FMU office to notify them of your departure.

PJMT ENTRANCE CONTROL: Contact Mike Green (690-1668) or Bill Cox (690-1667), of the Los Alamos Ski Club, to obtain permission to go up the mountain. Sign the access log book at the mountain access control gate.

PJMT EXIT CONTROL: Contact the person who granted entrance and notify that person that you are off the mountain and sign the access log book indicating that you are exiting the mountain.

ITEM 5. HAZARDS MITIGATION

4. This topic is covered in the Employee Notebook required reading for all employees. The prospect of encounters with snakes and venomous insects requires the worker to be aware of his surroundings. Especially, watch where you step and where you place your hands.

5. Slips, trips and falls can occur anywhere and are of greater potential in the field environment where this instrumentation is located. The worker must be aware of his surroundings and use commensurate caution.

6. Ladders are frequently used to access instruments. Ensure that the ladder is properly placed on level ground with a solid footing so that it does not shift when the worker is on the ladder. The ladder must be positioned so that the worker does not have to over-extend and therefore unbalance the ladder. The worker shall not stand on the top two steps of a ladder. Workers will take the laboratory ladder training course.

7. Ensure that hand tools are in good condition and are proper for the application.

8. As with hand tools, ensure that power tools are in good condition and are proper for the application.

9. Use proper lifting techniques.

10. In the rare event that work is performed after dark, the workers will wear a headlamp style light, carry a flashlight, or aim the vehicle headlights at the work area.